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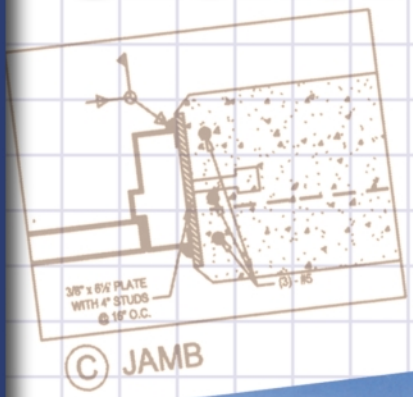
Design and Construction Guidance for Community Shelters



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Preface

Having personally seen the devastation caused by natural disasters, I am heartened to now see hundreds of communities commit to becoming disaster-resistant through FEMA's nationwide initiative, Project Impact. Project Impact operates on three simple principles: preventive actions must be decided at the local level; private sector participation is vital; and long-term efforts and investments in prevention measures are essential. The Federal Emergency Management Agency is committed to continue to develop tools, such as this manual, to help individuals, communities, states, and others create sustainable, disaster-resistant communities.

When severe weather threatens, individuals and families need to have a safe place to go and time to get there. Thousands of safe rooms have been built based on FEMA designs, providing protection for families in their homes. Where will these people go if they are not at home? This manual provides specific guidance on how to provide effective shelter that can save lives when severe weather threatens away from home.

James L. Witt
Director, Federal Emergency Management Agency

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Project Team

The Project Team comprised engineers from FEMA's Mitigation Directorate, consulting design engineering firms, and university research institutions. The role of the Project Team was to follow the plan indicated by the Conceptual Report and produce this guidance manual. All engineering and testing efforts required to complete this project were performed by the Project Team.

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Review Committee

The Review Committee was composed of design professionals; representatives of Federal, state, and local governments; and members of public and private sector groups that represent the potential owners and operators of community shelters. The role of the Review Committee was to provide peer, industry, and user group review for the guidance manual. The committee helped direct the development of shelter design and construction guidance to ensure that the information presented in this manual is accurate, clear, and useful to the intended users.

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Acronyms and Abbreviations

The following acronyms and abbreviations are used in this manual.

Acronyms

ACI – American Concrete Institute International

ADA – Americans with Disabilities Act

APC – atmospheric pressure change

ASCE – American Society of Civil Engineers

ASD – Allowable Stress Design

B/C – benefit/cost

BPAT – Building Performance Assessment Team

C&C – components and cladding

CMU – concrete masonry unit

EOC – Emergency Operations Center

FEMA – Federal Emergency Management Agency

HAZMAT – hazardous material

HVAC – heating, ventilating, and conditioning

IBC – International Building Code

ICC – International Code Council

ICF – insulating concrete forms

IDR – Institute for Disaster Research

IMC – International Mechanical Code

IRC – International Residential Code

LRFD – Load and Resistance Factor Design

MRI – mean recurrence interval

MWFRS – main wind force resisting system

NCDC – National Climatic Data Center

NEHRP – National Earthquake Hazard Reduction Program

NFIP – National Flood Insurance Program

NOAA – National Oceanic and Atmospheric Administration

NPC – National Performance Criteria for Tornado Shelters

NWS – National Weather Service

o.c. – on center

RCC – Regional Climate Center

RO – Regional Office

SERCC – Southeast Regional Climate Center

SFHA – Special Flood Hazard Area

SPC – Storm Prediction Center (NOAA)

TTU – Texas Tech University

UBC – Uniform Building Code

WERC – Wind Engineering Research Center (TTU)

WLTF – Wind Load Test Facility (Clemson University)

Abbreviations

C_p – external pressure coefficient (for MWFRS)

D – dead load

F – lateral force

fps – feet per second

ft^2 – square foot/square feet

G – gust effect factor

GC_p – external pressure coefficient (for C&C and attachments)

GC_{pi} – internal pressure coefficient

I – importance factor

I_e – impact energy

I_m – impact momentum

k – stiffness

K_d – directionality factor

K_z – velocity pressure exposure coefficient

K_{zt} – topographic factor

L – live load

lb – pound/pounds

M – mass

mph – miles per hour

p – pressure (in psf)

psf – pounds per square foot

psi – pounds per square inch

q_z – velocity pressure (in psf)

V – design wind speed

W – wind load as prescribed by code or ASCE 7-98

W_x – extreme wind load